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RESPONSIBLE INNOVATION AND THE INNOVATION OF RESPONSIBILITY:

GOVERNING SUSTAINABLE DEVELOPMENT IN A GLOBALIZED WORLD

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Abstract

Earth's life support system is facing megaproblems of sustainability. One important way of how these problems can be addressed is through innovation. This paper argues that responsible innovation that contributes to sustainable development consists of three dimensions: (1) innovations avoid harming people and the planet, (2) innovations 'do good' by offering new products, services or technologies that foster sustainable development, and (3) global governance schemes are in place that facilitate innovations that avoid harm and 'do good'. The paper discusses global governance schemes based on deliberation as a means to foster such responsible innovation. These schemes can provide voluntary soft-law regulations that complement and extend national and international hard-law regulations and facilitate collective innovation that contributes to sustainable development goals. The article addresses the facilitative role of governments and international organizations in overcoming problems of deliberation and offers illustrative examples of such governance schemes.

Keywords:

Responsible innovation, global governance, globalization, political CSR, sustainable development

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The United Nations Conference on Sustainable Development (UNCSD), also known as Rio+20, resulted in a nonbinding document in which the governments of various countries declared their commitment to create a set of sustainable development goals, or SDGs (UNCSD, 2012). These goals will be integrated into the framework of the Millennium Development Goals (MDGs) after 2015 (UN, 2012). This commitment reflects the realization that mankind needs to take action in order to guarantee a sustainable future for the planet as a whole and the people inhabiting it. However, studies suggest that the pace of climate change and other problems with a negative impact on Earth's life-support system is still increasing, despite international efforts to mitigate these problems (Griggs et al., 2013; Lomborg, 2004; Whiteman et al., 2013; for an overview of sustainable development challenges, see Table 1). Some boundaries that scholars have calculated for Earth's life-support system to be sustainable have already been crossed (see the 'planetary boundaries' by Rockström et al., 2009).

Sustainable development goals encompass protecting the Earth's life-support system and improving living conditions—for instance, by alleviating poverty and providing universal education (Griggs et al., 2013; Lomborg, 2004; Rockström et al., 2009). Innovation, understood as "the generation, acceptance and implementation of new ideas, processes, products or services" (Thompson, 1965, p. 2), is a key mechanism for achieving these goals. If people in developed countries do not want to sacrifice their living standards and people in developing countries want to improve their living conditions without impacting negatively the Earth's life-support system, it is necessary to create, implement and diffuse new products, processes and services that specifically address SDGs.

Scholars argue that business organizations, as an important source of innovation, have a social responsibility to help address issues of public concern that relate to sustainability,

given that they have the requisite resources and scope for action (Scherer and Palazzo, 2007; Schrempf, 2014; Young, 2011). However, we propose that scholars, practitioners and policy-makers need to consider three dimensions, if they want to ensure that business organizations are to contribute successfully to sustainable development (SD) through innovation. These dimensions can be subsumed under the term 'responsible innovation.' First, organizations need to make sure that innovations are responsibly developed and implemented; that is, that new products or services avoid harming people and the planet. We call this dimension the *'responsibility to avoid harm'*. Second, in order to improve living conditions and safeguard the Earth's life-support system, organizations should be provided with incentives to develop innovations that alleviate or reverse environmental depletion and social misery. We call this dimension the *'responsibility to do good'* (Stahl and Sully de Luque, 2014). Third, it is necessary to put in place global governance structures that facilitate the first and the second dimension of responsible innovation. We call this dimension the *'governance-responsibility'* of organizations. In this article we argue that this last aspect of innovation management is still not very well understood in the relevant literature nor implemented in practice, even though it is paramount to achieving innovation on a sufficiently large scale in order to have a positive impact on global SD.

In recent years, the scholarly debate has focused more closely on the capacity of firms to create innovations that foster SD (Gao and Bansal, 2013; Hart, 1995; Hoffman, 2005; Shrivastava, 1995; Siegel, 2009). With regard to the responsibility to avoid harm, scholars discuss risk-management frameworks for innovations on the organizational level that do not harm either clients or the environment. And on the industry or national level, regulations aimed at the same purpose (Busch and Hoffmann, 2007; Owen et al., 2013a; Stilgoe et al., 2013). With regard to the responsibility of organizations to 'do good', concepts such as 'social entrepreneurship,' the 'creating shared-value framework,' 'eco' or 'green' innovations and 'sustainability-oriented' innovations have gained prominence in recent years (Hielscher

and Vennemann, 2014; Karakaya et al., 2014; Porter and Kramer, 2006, 2011; Schiederig et al., 2012). Studies in this body of literature often argue that social and environmental innovations can create economic benefits and business opportunities. A limitation of both streams of research is that scholars consider each of these two aspects separately and focus primarily on either the responsibility to prevent harm *or* the responsibility to 'do good', but have yet to consider both dimensions and their prerequisites at the same time. Furthermore, the analysis of firm-level innovations for SD is not yet meaningfully connected to global-level facilitation of responsible innovations (Whiteman et al., 2013). We argue that, to contribute successfully and comprehensively to SD, organizations need to embrace both aspects and, by extension, that researchers need to consider them concurrently. The third dimension, 'governance'-responsibility, seems to be the key factor in this endeavor, because it operates on a meta-level, i.e. it facilitates the other two dimensions of responsible innovation, and influences decisively the way in which corporate innovations contribute to SD (see Figure 1).

Figure 1 about here

Scholars who study SD and initiatives that focus on governance target primarily national governments or intergovernmental regulations and do not give enough consideration to the possible implications for or contribution of business firms (see, e.g., Galaz et al., 2012; Griggs et al., 2013; Lomborg, 2004; Reischl, 2012; see also, Abbott, 2012). Yet, the challenges of global SD extend inevitably beyond the reach of the regulatory power of individual countries (Kaul et al., 2003). As a consequence, SDGs seek to address problems that cannot be solved by single actors, be it national governments, firms, or other societal groups. For instance, it stands to reason that it is not feasible for any country to reverse climate change or stop global warming single-handedly. Moreover, there is no binding regulatory framework on the global level. As the example of the Rio+20 summit shows, even though governments realized that it needs action, they found it difficult to agree on common

goals of mitigating climate change and committed themselves to the minimal consensus of defining SDGs by 2015, instead (UNCSD, 2012); furthermore, business firms can avoid strict national regulatory frameworks by shifting their value chain activities to countries where these regulations do not apply (Kobrin, 2001, 2009).

This raises the following questions: first, what is the appropriate model of governance in a globalized world that can help to guarantee that innovations prevent harm and facilitates innovations that 'do good'? Second, which actors and institutions are responsible for SD? Third, how can the SD activities of governments, businesses and civil society be coordinated? Fourth, how can the social and technical innovations that support SD be created and diffused? With these key questions in mind, in this article we develop the idea that corporate social responsibility (CSR) that fosters responsible innovation imparts to business organizations a political role and that SD requires, first, collective problem-solving to encourage innovations that 'do good' and second, 'soft-law' arrangements that promote the development of innovations that avoid harm. We furthermore build on the concept of political CSR (Mäkinen and Kourula, 2012; Scherer and Palazzo, 2007, 2011; Scherer, Palazzo, and Seidl, 2013) to envision a global governance framework for responsible innovation.

We thereby contribute to the literature by providing a holistic view on responsible innovation for SD. Additionally, we integrate different streams of literature on boundary conditions of Earth's life-support system, business innovation, and CSR that have not yet been meaningfully connected (for exceptions, see Whiteman et al., 2013). Finally, we discuss the advantages and limitations of deliberative global governance schemes in contributing to responsible innovation, and point toward the facilitative role of governments and international organizations to overcome some of these limitations. In the first part of the article (titled 'Current approaches to responsible innovation'), we therefore discuss how current literature conceptualizes responsible innovation. In the second part (titled 'Toward an innovation of responsibility'), we sketch an extended understanding of responsibility with regard to

innovation by drawing on political CSR and relate it to initiatives of global governance that are conducive to innovations that contribute to SDGs.

Current approaches to responsible innovation

The Technology and Innovation Management (TIM) Division of the Academy of Management is an important community for international scholars interested in innovation management. Surprisingly, in the 'Domain Statement' of the Division (TIM, 2014), which defines the content of the research domain, there is no reference to the responsibility that the management of technology and innovation carries, nor do the words 'sustainability' and 'ethics' appear in this statement. Furthermore, the ongoing discussion on the CSR of businesses, defined as "actions that appear to further some social good, beyond the interests of the firm and that which is required by law" (McWilliams and Siegel, 2001, p. 117), involves only marginal references to innovation management (Hielscher and Vennemann, 2014). However, if we define responsible innovation as innovation that fosters SD, in that it does not harm people and the planet and improves conditions for both, these aspects of responsible innovation are clearly part of the scholarly discussion. As already mentioned, most research focuses on either the first or the second aspect of responsible innovation. With regard to the prevention of harm, some scholars and policy-makers focus on risk management frameworks for the purpose of keeping under control the potentially harmful consequences of new technology and innovation in general. With regard to improving living conditions through innovation, other scholars and practitioners focus on social and ecological innovations. Both views are presented in more detail in the following.

Responsible innovation means avoiding causing harm to people and the planet

The idea of responsible innovation is that new products should not damage the health of consumers and the general public, new processes should be safe for workers and everyone involved, and neither of these should pollute or harm the environment in any way. Innovation governance, understood as the process of regulating the creation and implementation of innovation, tries to account for these risks of innovation and technology development (Deschamps, 2012; Lee and Petts, 2013). The dangers of innovation lie in the 'dual use' or 'double effect' of innovation (Grinbaum and Groves, 2013; Kaiser and Moreno, 2012; Stilgoe et al., 2013). In other words, innovations can be beneficial as well as harmful both to people and the environment—nuclear fusion is a prominent example of this double effect. Another consideration is the uncertainty regarding the future uses of a new product or process (Grinbaum and Groves, 2013; Lee and Petts, 2013); that is, there is an information asymmetry between current knowledge and the possible, and usually unintended, negative consequences of innovation and technology in the long run—the originally unforeseen consequences of the pesticide DDT are a poignant example (Sykes and Macnaghten, 2013, p. 86).

To account for the risks of innovation, scholars and practitioners envision and design regulatory frameworks at the organizational level in the form of various approaches to risk management. These include, for instance, devising standardized procedures for the clinical testing of new medications or establishing ethics committees at universities. These mechanisms are complemented by regulations on the governmental or inter-governmental level (Lee and Petts, 2013). In Europe, for instance, there are 'general liability regimes' in place to ensure that innovations do not cause any harm, such as the General Product Safety Directive or the Product Liability Directive, which apply to all EU member states (EU, 2014a, b).

Overall, regulations on innovation are shaped "according to three axes, namely product type (toys, food, pharmaceuticals, etc.), points in the product lifecycle (research and

development (R&D), introduction to the market, end of life, and the like) and objective (worker or consumer safety, environmental protection, etc.)" (Lee and Petts, 2013, p. 150). The resulting regulatory mechanisms are predominantly based on assumptions of liability and on utilitarian cost–benefit analyses (Grinbaum and Groves, 2013; Stilgoe et al., 2013). Responsibility in the sense of liability means that practitioners, policy-makers and scholars base their suggestions for and evaluations of innovation governance on the assumption that businesses are only responsible, and can thus be held liable, for the damage they directly cause (see critically, Young, 2011). Innovation governance is regarded as a mechanism that can prevent businesses from causing damage in the first place. Internal risk-management systems function according to this logic. Similarly, regulations on product innovation are often based on 'general liability regimes' whose purpose is to guarantee that, for example, new pharmaceutical products or novel food products do not have any negative effects on consumers (Lee and Petts, 2013, p. 151; Timmermans et al., 2011). In the US, for instance,

> manufacturers that develop and sell new products are regarded under US law as also providing an implied warranty of 'fitness for the intended use.' If a product does not meet this criterion, and if a different, written warranty is not in place, manufacturers can be found liable for negligence with respect to providing a defective design and failure to warn buyers. (von Hippel, 2005, p. 50)

Both organizational and governmental mechanisms try to ensure that businesses can be held liable for the potential negative consequences of their operation by introducing sanctions and controls. Apart from questions of liability, the regulation of innovation is also determined by utilitarian cost–benefit analyses that weigh the potential benefits of innovations against potential risks (Grinbaum and Groves, 2013). The assumption is that internal and external evaluators (i.e. within organizations and representatives of regulatory bodies respectively) can adequately estimate the consequences of a new product or service on the basis of data

gathered before the product or service is launched and decide whether to grant the relevant license or permit accordingly.

However, risk-based regulatory frameworks that rely on the idea of responsibility as liability and on utilitarian estimates have their limitations (Grinbaum and Groves, 2013; Stilgoe et al., 2013). One main limitation is that the basic assumption underlying such frameworks is that the future is predictable and calculable. As a result, the regulatory designs they offer reflect strict, rule-based approaches that depend on the ability to predict the future. However, unforeseen developments, as well as the possible unintended consequences and long-term negative effects of innovations cannot always be determined or accurately estimated a priori (Lee and Petts, 2013). In addition, such frameworks are relatively inflexible as sanctions need to be tailored to predetermined offenses and thus cannot easily accommodate new offenses that may arise from unforeseen harmful consequences of innovations.

In view of the above, we follow the suggestion of Stilgoe et al. (2013, p. 1570), who argue that approaches to responsible innovation should "move from the governance of risk to the governance of innovation itself." The authors have developed a framework for responsible innovation that encompasses forward-looking and inclusive dimensions of responsibility; namely, anticipation, reflexivity, inclusion and responsiveness (see also, Owen et al., 2013b). Similarly, Grinbaum and Groves (2013) argue for a more proactive understanding of responsibility with regard to innovation. They propose that innovators should view the responsibility for their innovations as similar to the responsibility that parents feel for their child. Responsibility that is based on being considerate is forward-looking and avoids analyses of the cost–benefit tradeoff, which is hard to calculate (Grinbaum and Groves, 2013). Furthermore, the same authors argue that it is important to develop a collective sense of political responsibility, as a result of which the innovator, as a member of a social group, "has to ask herself about the wider social and political significance of what she intends to

accomplish, and what her actions may accomplish despite her intentions" (Grinbaum and Groves, 2013, p. 133). Both approaches to responsible innovation point out that it is more important for actors to develop a capacity for self-regulation and for proactive action than to rely solely on hard-law regulations. However, this capacity of business firms for self-regulation is not yet sufficiently recognized in current research, as research on innovation regulation to date argues predominantly for solutions on the governmental or intergovernmental level (Galaz et al., 2012; Reischl, 2012; Whitman et al., 2013).

Responsible innovation means doing good to people and the planet

In recent years, scholars have started to theorize on the relationship between SD and organizational innovation from a strategic management theory background. The models that these scholars employ to explain why firms engage in SD include mainly the resource-based view (Bansal and Roth, 2000; Hart, 1995; Meyskens and Carsrud, 2013; Shrivastava, 1995), the theory-of-the-firm perspective (Siegel, 2009) and transaction cost economics (Hoffman, 2005; Orlitzky et al., 2011). In those works, SD is often regarded as a firm's contribution to the 'triple bottom line' (Elkington, 1998) of environmental integrity, social equity and economic prosperity (Bansal, 2005).

Strategic approaches to SD that draw on the resource-based view assume that investing in SD can create a sustainable competitive advantage for businesses by enabling them to develop firm-specific social or environmental capabilities that competitors cannot imitate easily. An example would be the ability to develop close relationships with individual stakeholders that help reduce conflicts among competing stakeholders and enhance the firm's reputation (Gao and Bansal, 2013). Other studies have argued that innovations that aim to reduce carbon emissions can help firms gain a competitive advantage by increasing their efficiency in energy use and thus reducing costs or increasing revenue (Busch and Hoffmann, 2007; Hoffman, 2005). Strategic approaches drawing on the theory-of-the-firm perspective

regard social and ecological innovations as potential drivers for successful product differentiation (McWilliams and Siegel, 2001).

Thoughts based on these theories resulted in concepts like social innovation, eco-innovation, social and environmental entrepreneurship, or the 'creating shared value' approach, whereby a general assumption is that SD innovations are profitable for firms. Pooling together various definitions of eco-innovations, Schiederig et al. (2012, p. 182) have summarized six aspects that illustrate the concept well: eco-innovations target a specific innovation object (product, service, process), have a market orientation, reduce the negative impact on the environment and take into consideration the full life cycle of a product or process, while the intention of actors for investing in eco-innovations may be economical or ecological and the focus of analysis is on the firm-level. These dimensions highlight the combination of profit orientation and social or environmental improvements, as well as a focus on organizational innovation, as prominent features of innovations that 'do good' that are currently discussed in the literature. One limitation of this literature is the focus on the strategic level of the firm. Scholars do not explain how such innovations can be facilitated on a global scale (Whiteman et al., 2013).

With regard to the scale of innovation aiming at sustainability, Szekely and Strebel (2013) identified three levels: incremental, radical and game-changing innovations. *Incremental* innovations in products, services and processes involve gradual improvements in eco-efficiency or environmental management systems, for example. Eco-efficiency innovations may aim to increase efficiency in electricity usage, in heat production or in transportation. Environmental management systems may comprise process innovations in practices of social or environmental reporting and improvements in quality management systems. Examples of *radical* innovations are ecological innovations that concern the entire life cycle of a product and may involve environmentally friendly use, reuse and recycling, or process innovations that help transform the supply chain to improve working conditions in

developing countries. Finally, Szekely and Strebel (2013) propose that social entrepreneurship can create *game-changing* innovations, if the resulting innovations are sufficiently widely distributed, as, for instance, in the case of microfinance or base-of-the pyramid ventures (London and Hart, 2011).

While social and ecological innovations are generally regarded as positive, the reasons why organizations should actually invest in such innovations are still contested. The discussion centers on the question of whether investing in such innovations needs to 'pay'; in other words, of whether organizations should—and do—invest in social and ecological innovations only for instrumental economic reasons or also for other, non-financial reasons (Gao and Bansal, 2013; Marcus and Fremeth, 2009; Siegel, 2009). Part of the reason why this discussion is ongoing is that there is no conclusive empirical evidence of a positive link between investing in CSR and enhanced financial performance (Margolis and Walsh, 2003; Schreck, 2011). The argumentation presented in the literature is based predominantly on an 'either–or' logic; that is, scholars argue either from an instrumental economic viewpoint or from a non-instrumental, normative-ethical viewpoint (Gao and Bansal, 2013).

This 'either–or' argumentation, however, fails to capture the complexity of the motives behind the decisions of the actors involved in strategic decisions on new innovations, as well as of the different institutional expectations that these actors face and tends to oversimplify strategic decision-making in organizations (Gao and Bansal, 2013; Scherer et al., 2013). In this regard, Gao and Bansal (2013) argue that an integrative logic that acknowledges the interdependence and inclusiveness of the sustainability 'tripod' of economic, social and environmental aspects can help strike a balance between these two viewpoints. Integrative thinking differs from instrumental thinking in its temporal orientation, spatial orientation and focus. With respect to temporal orientation, instead of being dominated by short-term economic concerns, it integrates short-term economic, medium-term social and long-term ecological considerations. With respect to spatial orientation, it tries to integrate various

organizational actors and structures simultaneously, rather than sequentially, to create a holistic SD strategy, while its focus is on an ethic of care, as opposed to an ethic of justice and fairness (Gao and Bansal, 2013).

Integrative logic can be taken as a starting point for designing schemes of global governance that are conducive to innovations that 'do good'. We propose that global governance initiatives can be designed to accommodate both an economic and a non-economic logic. Indirect economic incentives provided to participating organizations might include reputational benefits and favorable relations with stakeholders that grant a competitive advantage through the exchange or pooling of resources, cost savings based on overcoming the need for stricter and more costly hard-law regulations, and increased possibilities for innovations through exposure to a wider knowledge network (Vaccaro et al., 2009). Non-economic incentives might include learning opportunities, the ability to comply with institutional expectations and the satisfaction of doing something good for the planet and its population. Collaboration with NGOs can furthermore, "facilitate access, distribution and legitimacy of products in particular markets" (Meyskens and Carsrud, 2013). Such governance schemes provide sufficient room for the integrative logic of combining short-term economic and long-term social and environmental goals, bringing together otherwise independent actors and consideration for people and the planet as a whole.

Toward an innovation of responsibility: Political CSR as a framework for governance, responsibility and innovation

There is little doubt that the Earth is facing man-made 'megaproblems' of sustainability (BMU, 2008). In response to these megaproblems, researchers have started to identify and quantify so-called 'planetary boundaries' that indicate the limits of the planet's life-support systems. Table 1 presents an overview of two exemplary approaches to this issue. 'Planetary boundaries,' together with the social dimension of the current MDGs, provide a starting point

for defining SDGs. Griggs et al. (2013, p. 306) identify a set of six SDGs that can serve as a follow-up to MDGs after 2015 (see Figure 2).

Table 1 about here

Figure 2 about here

Business innovations are an important means of reaching SDGs. However, for such innovations to emerge, it is necessary to put in place governance mechanisms that facilitate SD innovations. Griggs et al. (2013, p. 307) identify the challenge of creating "governance for sustainable societies" as one of these six SDGs and call for transforming "governance and institutions at all levels to address the other five sustainable development goals." The authors primarily address policy-makers at the national governmental and transnational intergovernmental levels; i.e., the actors who should provide the necessary regulations or incentives for sustainable business—for example, by eliminating subsidies on fossil fuels or by implementing national monitoring, reporting and verification systems for SD targets. However, the authors' focus is not broad enough to encompass the dominant role of business organizations in co-creating global governance and providing global public goods (Kaul et al., 2003; Scherer and Palazzo, 2011) or the many emerging governance arrangements that integrate governments, businesses and civil society representatives (Abbott and Snidal, 2010; Waddock, 2008). Furthermore, Griggs et al. view governance as 'merely' the sixth goal that needs to be pursued in order to achieve sustainable development. Yet, governance is a prerequisite for reaching the other SDGs that the authors identify: without the appropriate structures and processes for steering and regulating activities, there can be no concerted action to achieve SD (Abbott, 2012).

In the following, we focus on how global coordinating mechanisms that specifically include business organizations alongside other global actors can facilitate responsible

innovations. We draw on theories of political CSR to carve out the role and responsibilities of businesses in global governance. Political CSR rests on the assumptions that public and private actors share the responsibility for sustainable development and adequate regulations, and that these actors create jointly the institutional framework for responsible innovation (Scherer and Palazzo, 2007, 2011). This requires governance schemes that accommodate the political role of the firm. Matten and Crane (2005) point out that business organizations assume political roles when they act as corporate citizens who provide social rights (e.g., by providing education or improving working conditions), enable civil rights (e.g., by protecting workers' rights or not becoming complicit in civil rights abuses) or channel political rights (e.g., by lobbying against oppressive regimes or engaging in global governance for SD). The political engagement of businesses involves providing public goods or engaging in social or environmental issues, either by supplementing public services or by helping governments build up their capacity (Valente and Crane, 2010) and is especially prevalent in multi-stakeholder schemes of global governance (Mena and Palazzo, 2012).

In the following, we discuss the characteristics of 'governance responsibility' in the context of four interconnected aspects that result from the global nature of SD challenges and from the political role of business organizations. These are derived from Scherer and Palazzo's discussion (2011) of the new concept of political CSR and include (1) the transition from national to global governance, (2) the contribution of soft law to international regulation, (3) the awareness that responsibility for SD is a collective responsibility and (4) the advantages of global governance based on the principles of deliberative democracy.

The appropriate model of innovation governance for tackling the challenges of sustainable development: From national to global governance

The discussion about the challenges of global sustainability that we reviewed in the previous section shows above all that these challenges cannot be tackled by individual countries single-

handedly. Nevertheless, regulatory frameworks whose purpose is to facilitate innovations that do not harm people and the planet and to provide incentives to invest in do-good innovations remain primarily within the remit of the national government. Such frameworks may concern, for example, achieving energy efficiency on the national level, providing subsidies for renewable energy or devising national policies on the reduction of CO_2 emissions. A further difficulty is that, as Abbott and Snidal (2010, p. 315) observe, "scholars and practitioners assessing IO [international organizations'] performance frequently focus on traditional modes of governance such as treaties and inter-state dispute-resolution mechanisms. When they observe poor performance, moreover, they often prescribe a strengthening of those same activities".

However, while SD problems are global in scope, the capacity of individual countries to regulate such problems and innovations is limited, given that such regulations are bound to a state's territory and cannot be enforced globally. Apart from that, it is necessary to take into account the case of failed states that have no adequate rule of law or no interest in either regulating SD or facilitating responsible innovation. Moreover, it is not only failed states that may lack the motivation to achieve SDGs: states that have a well-functioning regulatory system at their disposal may face domestic political constraints, such as pressure from influential lobbying groups; an example of this are the challenges that the Obama administration faces in the US with regard to the President's action plan for climate change (Howard-Grenville et al., 2014). Furthermore, responsibility for causing the problems that SD seeks to alleviate cannot be attributed to a single actor—for instance, the pollution that has caused and is still exacerbating global warming is not produced by a single state or business firm. However, achieving and enforcing collectively inter-state agreements whose signatories undertake to meet SDGs is hard, as the limited achievements of global climate conferences show (Schüssler et al., 2014).

The above makes clear that orchestrating responsible innovation effectively, i.e. ensuring that businesses pursue innovations that comply with the principles of SDGs by doing good and avoiding harm, requires global governance solutions. These should facilitate collective problem-solving in which both those causing and those affected by a given problem are involved (Scherer and Palazzo, 2007). Currently, the global institutional context increasingly involves business organizations in policy-making, mainly through voluntary self-regulatory initiatives, coupled with monitoring and reporting standards (Abbott, 2012; Waddock, 2008). Abbott and Snidal (2010, p. 315) argue that, with proper orchestration by international organizations, what they call 'transnational new governance' that includes governments, business organizations and NGOs, can ameliorate both 'state failure' and 'market failure'; that is "the problems that result when the creation and evolution of norm-setting institutions is highly decentralized."

How to facilitate the responsibility to avoid harm: From hard-law to soft-law regulations on innovation

Responsible innovations that contribute to SD need first and foremost to avoid harming people and the planet in general. The prevention of harm is traditionally promoted through binding legal rules and potential sanctions in cases of non-compliance (hard law). However, the governance of innovation involves particular challenges: first, due to the globalization of businesses operations, business innovations also become increasingly global in scope. The "propensity of products to have global reach […] poses one of the greatest regulatory difficulties," because the regulation of innovation is "strongly national in focus and sensibilities" (Lee and Petts, 2013). The regulatory difficulties arise because multinational organizations can relocate their value-creating activities to avoid legal constraints, which, in most cases are confined to national jurisdiction (Scherer and Palazzo, 2011).

Moreover, the speed of innovation has been increasing exponentially since the last century (Owen et al., 2013a). This makes it difficult to control every innovation in due time and strains the limited resources of governmental authorities that enact and enforce hard-law regulations. In addition, innovation is directed toward the future, which poses difficulties, considering that it is hard to foresee all possible negative consequences for people and the planet (especially during the initial phase of creation or invention) and incorporate sufficient provisions in codified hard-law regulations, which are relatively inflexible. Owen et al. acknowledge that

> we know from experience that the reach of innovators will always exceed the grasp of regulators, and that it is often many decades before understanding of the wider impacts, implications, and consequences of innovations become clear enough for a case for a regulatory response to be made. (Owen et al., 2013b, p. 33)

In this regard, soft law, which "operates without a governmental power to enforce rules and to sanction deviant behavior" (Scherer and Palazzo, 2011, p. 907), can serve as a complementary means of facilitating innovations that do not harm society and the environment. Soft-law relies on businesses to apply voluntary self-regulation, particularly in cases where governments are unable or unwilling to provide sufficient regulations (Bailliet, 2012; Mörth, 2004). Governance based on soft law includes self-regulatory multi-stakeholder initiatives that help certify social or environmental business practices, such as the Global Reporting Initiative, or provide labels for products that try to signal through transparent information that an organization avoids harming people or the environment. Examples of the latter type of governance are organizations that grant product labels like Fairtrade for ethically farmed products, or the Forest Stewardship Council (FSC) label, which indicates that a company promotes responsible forest management. Other organizations, such as the UN Global Compact (UNGC) center on principles in the areas of human rights, labor, environment and combating corruption (UNGC, 2014), which signatories commit to uphold and which serve as

guidelines for corporate CSR (Rasche et al., 2013; Voegtlin and Pless, 2014). Furthermore, within supply chains soft-law regulations are a means of preventing process innovations from causing harm to the society or the environment. For instance, in the context of the Roundtable of Sustainable Palm Oil, the WWF collaborates with businesses to map the rainforest and ensure that companies do not invest in palm-oil projects that result in the depletion of rainforest areas, but only in existing plantations (RSPO, 2014).

These are just a few examples of emerging global governance initiatives that provide soft-law solutions to the problem of SD. These initiatives differ in quality and scope with regard to the requirements that firms have to meet. Furthermore, their legitimacy and effectiveness depends on the design and robustness of their internal governance (Mena and Palazzo, 2012; Voegtlin and Pless, 2014). However, in general, soft-law mechanisms can help overcome the limitations of hard law in global governance for responsible innovation. More specifically, soft law can extend the limited scope of hard-law regulations that affect multinational organizations by involving these organizations—which are the main source of innovation—in the process of norm-setting and thereby securing their commitment. In addition, soft-law mechanisms make it possible to regulate innovations globally, even if only on a voluntary basis and with varying success. Overall, the rise of self-regulatory standards and the proliferation of relevant initiatives show that, despite some drawbacks, soft law can cover a wide range of innovation processes and types of innovation; for example, it can promote commitment to the responsibility to avoid harm for product innovations or for process innovations along the supply chain. In addition, commitment to soft laws can also be a starting point for creating new innovations, as regulations that become accepted as industry standard or that serve as benchmarks can "reduce uncertainty and create long-term stability for industries to innovate, invest and compete" (Nilsson and Persson, 2012, p. 67).

With regard to how fast and in what direction an innovation is developed, the soft-law agreements of self-regulatory global governance initiatives can accommodate the unforeseen

negative consequences of innovations more flexibly than hard-law mechanisms. For example, soft law provides organizations with sets of general principles, such as those of the UNGC, that cover standards of 'good conduct' and apply to the whole innovation process, regardless of the nature of the innovation. Monitoring frameworks like the Global Reporting Initiative (GRI) complement these principles with more detailed guidelines for what constitutes desirable social and environmental conduct. These complementary mechanisms are also more flexible than hard-law regulations in adapting to new circumstances—for example, the GRI has already been updated for the fourth time since the first guidelines were launched in 2000 (GRI, 2014). Moreover, soft law relieves overburdened state agencies whose task it is to deal with hard-law regulations, and can highlight issues that might need to be regulated by means of hard-law measures in the future. In that respect, soft-law regulations can be regarded as the first step in the regulation of innovation (Lee and Petts, 2013).

How to facilitate the responsibility to 'do good': From private investment to collective innovations

Governance schemes that seek to ensure that innovations do not harm people and the planet as a whole are not sufficient for tackling the SD challenges that the global society has to meet. If mankind does not slow down the rate of consumption of resources that cannot be renewed, the planetary boundaries will soon be reached and people in third-world countries will continue to suffer from unsustainable working conditions (Lomborg, 2004; UN, 2012). To meet those challenges successfully, it is necessary to promote innovations that actually benefit both society and the environment; that is, innovations that promote directly SDGs. Grinbaum and Groves (2013, p. 119) argue that "we have to acknowledge that the responsibility associated with innovation necessarily is *responsibility for the future it helps to create*."

Two models are prevalent in the debate on why firms engage in innovation, based on different assumptions about how businesses can be encouraged to innovate (von Hippel and

von Krogh, 2003). The 'private investment' model assumes that firms will only innovate if they can reap economic benefits from investing in those innovations. The resulting innovations are private goods (Mankiw, 2001), i.e. goods that are excludable (the economic benefits are exclusive to the innovators) and rivalrous (consumption by one person prevents consumption by another person). This model further assumes that in order to encourage innovations it is necessary to grant intellectual property rights to ensure that the innovators have the monopoly of control over their innovations and can earn profits from marketing those. Scholars promoting the model and state authorities providing incentives for private investments in innovation take into account the potential loss to society from not making new technologies or knowledge accessible to all in order to encourage innovation in the first place (Grinbaum and Groves, 2013; von Hippel and von Krogh, 2003).

Governance mechanisms that try to encourage innovation in the area of SD and are based on the assumptions of the private investment model provide economic incentives for business firms (such as subsidies for renewable energy) and bar imitators from profiting from somebody else's innovation by granting property rights (such as patents on new technology) to its authors. This approach has certain implications for SD innovations. First, it rests on the assumption that business firms only foster innovations compatible with SD if they see an economic benefit in such endeavors. Second, it views social and technical innovations primarily as a response to the incentives provided by the market and the legal frameworks that are in place. Third, it assumes that the legal mechanisms that safeguard property rights function as planned.

On the whole, governance schemes that are based on the private investment model are not sufficient to foster innovations that 'do good' and that are compatible with SDGs, because the ability or motivation of governments or inter-governmental organizations to provide the necessary incentives for SD innovations is limited and varies considerably among different countries (Chandler and Mazlish, 2005; Kobrin, 2001). Moreover, national authorities have a

limited ability to guarantee property rights globally (e.g., Switzerland had no influence over the patent dispute of a new cancer drug between the Swiss based pharmaceutical company Novartis and the Indian government. Novartis lost the case and India denied the patent; Boseley, 2013). Furthermore, many innovations that promote SD tend to provide solutions to problems that concern public goods—such as providing clean water or improving education—which makes it more difficult to privatize the profit and to exclude others from the benefits these innovations bring.

In contrast to the private investment model, the 'collective action model' aims to foster innovation under conditions of market failure and applies to the provision of public goods (von Hippel and von Krogh, 2003). This model makes new knowledge accessible to society and excludes no one from its benefits. The kind of collective action that results in innovations is often encountered in science and in technology—examples are open-source software solutions (von Hippel and von Krogh, 2003). Governance schemes that can encourage collective action seem to provide a more promising solution for promoting innovations that are compatible with SDGs. However, collective action creates agency problems among firms because it allows 'free riders' to reap the benefits of an innovation without investing in its creation and implementation (Berliner and Prakash, 2014; von Hippel and von Krogh, 2003). Consequently, this model requires mechanisms that encourage firms to engage in collective action on the basis of incentives that are not limited to purely economic benefits. Initiatives that aim to foster innovation through collective action may thus provide reputational benefits, as well as learning opportunities (Palazzo and Scherer, 2010). Furthermore, information advantages that can be gained through collaboration can provide incentives to participate (Meyskens and Carsrud, 2013).

With regard to social and environmental problems, engaging in this kind of collective action could also serve as a means of risk management that enables business organizations to ward off unwelcome criticism, such as NGO campaigns that target possible shortcomings in

the social responsibility of business firms (Teegen et al., 2004). Finally, collective action approaches may well provide economic incentives. For instance, a social or ecological innovation could create value for a company that reflects all three elements of the triple bottom line (Gao and Bansal, 2013). Collaboration between a company and stakeholders who can bring in new ideas and specialized expertise can prove conducive to such innovations. Innovations need thereby not always be co-created by the participants of the governance scheme. Collaborative efforts can help to create new ideas for SD in the first place, which business organizations can then use to develop toward innovative products or processes. Collective action offers business organizations possibilities for ambidextrous solutions by increasing the "organization's ability to be aligned and efficient in its management of today's business demands while simultaneously being adaptive to changes in the environment" (Raisch and Birkinshaw, 2008, p. 375).

Overall, global governance schemes that encourage collective problem-solving require mechanisms that enable businesses to participate in the innovation process in order to gain reputational and learning benefits. These schemes can thereby range from weak coordination among actors with the primary goal of information exchange, to tight coupling and close collaboration where actors co-create innovative solutions (Galaz et al., 2012; Rasche, 2012). Below we outline how governance based on deliberative practices can provide such mechanisms.

How to orchestrate governance for responsible innovation: From liberal democracy to deliberative democracy

Let us begin by summarizing the points made in the previous sections: first, to promote responsible innovation whose outcomes are compatible with SDGs, it is necessary to establish mechanisms of global governance that comprise multiple actors, including businesses and civil society organizations. These mechanisms should provide voluntary soft-law regulations

that complement and extend national and international hard-law regulations and facilitate collective innovation that contributes to SDGs (see Figure 3).

Figure 3 about here

In order to move from the state-centric approach to providing solutions to the problem of SD towards global governance, the clear separation of the political and the economic sphere has to give way to the political involvement of business and civil society representatives in norm-setting (Scherer and Palazzo, 2007, 2011). This requires that the institutional infrastructure of global governance in relation to SD be co-created by governments, the civil society and business actors. While the classic liberal model of democracy assumes that norm-setting lies in the custody of governments and that businesses have no political mandate, the "deliberative model of democracy is able to acknowledge the contribution of both state and non-state actors to global governance" (Scherer and Palazzo, 2011, p. 918). In deliberative democracy the political process is based on shaping the public will through "non-governmental organizations, civil movements, and other civil society actors who map, filter, amplify, bundle, and transmit private problems, values, and needs of the citizens" (Scherer and Palazzo, 2011, p. 918). Deliberation "includes a careful examination of a problem or issue, the identification of possible solutions, the establishment or reaffirmation of evaluative criteria, and the use of these criteria in identifying an optimal solution" (Gastil, 2000, p. 22; cited in Carpini et al., 2004, p. 317). This happens through debate and discussion among those participating in deliberation (Carpini et al., 2004; Thompson, 2008).

Deliberation (Bohmann and Rehg, 1997; Carpini et al., 2004; Habermas, 1998, 2001) contributes to global governance in two ways that can be seen as a response to the calls for soft-law regulation and collective innovation. First, it offers a mode of political coordination to the representatives of those that contribute to and those that are affected by social and environmental problems that enables all actors involved to solve these problems collectively.

Through deliberation, business and civil society organizations become political actors that can influence the global regulation of SD issues by means of self-regulatory initiatives that in turn affect governmental policies on these issues (Scherer et al., 2006; Scherer and Palazzo, 2011). Second, deliberation offers a way of organizing the governance of voluntary self-regulatory initiatives by promoting principles of open participation, balanced decision-making and transparency. In other words, according to the deliberative model of democracy all those potentially affected by a policy or issue should be guaranteed access to the process of public-will formation, the power of all actors involved should be balanced and the decision-making process should be open to public scrutiny (Habermas, 1998, 2001).

Soft-law solutions for responsible innovation based on deliberation can take the form of general principles or concrete guidelines for specific areas and issues. These solutions are politically binding, insofar as those participating in the process commit to the principles they have formed collectively (Thompson, 2008). The Forest Stewardship Council (FSC, 2014) is an example of a transnational governance scheme that provides concrete guidelines in a specific area; in this case, the forestry industry. Participation in the FSC is open and its members include business organizations, NGOs and representatives of local communities. The governance structure follows the deliberative principles of broad participation and of balancing the power of the participants (Scherer et al., 2006).

Global governance initiatives based on deliberation can also facilitate innovations that 'do good' by providing incentives for business firms to participate in collective problem-solving. Such incentives include access to information, reputational benefits and the prospect of minimizing problems of agency and 'free riding' by means of increasing transparency. Deliberation facilitates openness and transparency by offering private and public actors open access to the process of public-will formation and by granting participants a legitimate voice (Gilbert and Rasche, 2007; Scherer and Palazzo, 2007). Empirical research on deliberation has shown that providing participants an opportunity to voice their opinion leads to

perceptions of a fair process and legitimate outcomes, and to an increased willingness to cooperate (Carpini et al., 2004; for the positive impact of transparency, see Vaccaro and Echeverri, 2010). Critical societal groups such as NGOs can join the process of norm-setting and use their voice to intervene. In addition, they can monitor business behavior and expose signatories who attempt to shirk their commitment. The active participation of NGOs in turn, which may include monitoring businesses and calling them to task, when necessary, increases the credibility of an initiative and thus the business participants' reputation (Mena and Palazzo, 2012).

Moreover, deliberative global governance schemes provide opportunities for innovations for participating firms alongside the innovation process (Balconi et al., 2010; Crossan and Apaydin, 2010). Governance initiatives, in which a diverse set of participants collaborate with equal voice, offer learning platforms that provide spaces for the creation of new ideas and opportunities (Palazzo and Scherer, 2010). Open and balanced dialogue among different societal actors helps identify relevant SD issues and generate ideas for reaching SDGs. For instance, the 'Safety First Initiative', a public-private partnership that develops safety standards for agricultural biotechnology products highlights the benefits of deliberation in this area of SD:

> Our collaborations with a diverse range of stakeholders and responsible observers have demonstrated that public concerns about the risks of biotechnology can be addressed through such a participatory and open process to make safety a first priority in the development of biotechnological products. As a result, this Initiative is building a rare and extraordinary convergence among previously acrimonious parties in the agricultural biotechnology debate. (Kapuscinski et al., 2003, p. 599).

International organizations or NGOs can provide relevant expertise in social and environmental problem areas and can point out the most important SD areas in need of innovation. Deliberative global governance schemes can also underpin the development of

innovations by providing participants with possibilities to acquire and pool diverse resources. For example, the knowledge of NGOs and international organizations can help firms create capabilities for SD (Hielscher and Vennemann, 2014) and to leverage opportunities for sustainability that are compatible with their core competencies. For example, Holcim, a leading supplier of cement and concrete, collaborates with Ashoka, an NGO specialized on supporting social entrepreneurship, and Hystra, a consulting firm to design houses that are affordable for people living at the 'base of the pyramid', thereby creating product innovations that serve low income households (Samaranayake et al., 2011). Furthermore, the global spread of such initiatives can facilitate access to new markets and technologies, considering that business firms can collaborate with actors from around the world. Finally, deliberation helps implement and diffuse SD innovations by providing a mechanism for overcoming acceptance problems, as solutions produced through deliberative processes have been shown to be more readily perceived as legitimate than other modes of decision making by those affected by its implementation (Carpini et al., 2004). The resulting innovations are quasi-public goods that can diffuse more easily and widely than private innovations (Berliner and Prakash, 2014; Karakaya et al., 2014). The Stratospheric Particle Injection for Climate Engineering (SPICE) project, which "aims to assess whether the injection of sulphur particles into the stratosphere would mimic the cooling effects of volcanic eruptions and provide a possible means to mitigate global warming" (Macnaghten and Owen, 2011, p. 293), is an example of an initiative that tries to get public legitimacy for geoengineering innovations through deliberation with stakeholders and the public (Macnaghten and Owen, 2011; Stilgoe et al., 2013). This broad-based adoption and acceptance of sustainable innovations is essential for reaching SDGs.

The facilitative role of governments and international organizations in orchestrating the global governance of sustainable development

While the model of deliberative democracy offers solutions to the global governance of responsible innovation, public and private actors who want to establish such initiatives encounter difficulties in meeting the requirements of that mode of governance. These difficulties include encouraging relevant actors to participate in deliberation, guaranteeing a fair and balanced process of decision making, and producing effective solutions (Carpini et al., 2004; Thompson, 2008). Research in this regard has shown that the success of deliberation is dependent on contingency factors (Carpini et al., 2004). We argue that one such factor that can facilitate deliberation in global governance is successful orchestration of the efforts of public and private actors by governments or international organizations (Abbott and Snidal, 2009, 2010; Schneider and Scherer, 2014). 'Orchestration' is defined as the activities of governments and intergovernmental organizations that modulate

> the composition, structure, and procedures of private schemes to maximize their participatory and deliberative character and public interest orientation [...], help to rectify the uneven and suboptimal distribution of [regulatory] schemes [... and] reduce the bargaining problems that hamper collaboration by initiating desirable regulatory arrangements. (Abbott and Snidal, 2009, pp. 558–559)

Orchestration can be directive, i.e., initiated and controlled by governments or international organizations, or facilitative, i.e. supportive of self-regulatory global governance initiatives (Abbott and Snidal, 2010; Schneider and Scherer, 2014). Successful orchestration can ensure that access to the initiative is open to all that have a stake in the initiative's focal issue—the UN for instance, guarantees open access to the UNGC. More importantly, the influence of governments or legitimate international organizations can ensure that the initiative is not dominated by one actor or one group of actors, whether businesses or NGOs, and that all members participate on an equal

power basis (Abbott and Snidal, 2010). Responsible leadership by governmental actors in this regard can facilitate and moderate the dialogue among different stakeholders (Voegtlin et al., 2012). Furthermore, orchestration can "reduce transaction costs and bargaining costs by identifying and convening appropriate participants and facilitating negotiations" (Abbott and Snidal, 2010, p. 337), as well as increase the transparency of global governance by making procedures and outcomes public. Finally, orchestration can help generate new initiatives in areas that are not yet sufficiently regulated and to consolidate existing initiatives in other areas by setting a global standard. For example, the GRI and the Caring for Climate Initiative were co-founded by the UNEP. Especially the GRI has helped standardize social and environmental reporting globally (Abbott and Snidal, 2010).

Securing universal access to clean water: An illustrative example of global governance for responsible innovation with the aim of reaching SDGs

In order to illustrate the possibilities of deliberative global governance for responsible innovation and to point out the potential of successful orchestration, we discuss examples of governance schemes in the area of one of the SDGs, i.e., access to clean water. Access to clean water is one of the SDGs that have been identified as becoming potentially pressing in the near future (Lomborg, 2004; CEO Water Mandate, 2014). Rockström et al. (2009) set the threshold for sustainable global freshwater use to 4000 km^3 per year, while current usage already reaches 2600 km^3 (s. Table 1). However, resolving the problem of water scarcity is not merely a question of limiting the average use of clean water, but also of providing and sustaining access to drinking water. Water is also an important resource for business and agriculture and fundamental to the biodiversity of fresh-water flora and fauna.

An example of collaborative and deliberative governance of responsible innovation that supports sustainable development and combines soft-law solutions with innovations that

'do good' is the CALFED program in California, whose purpose is water management (CALFED, 2014). The CALFED water program started as a collaborative governance scheme based on deliberative democratic principles and comprised several stakeholders. More precisely, "over 25 federal and state agencies and representatives of more than 30 major stakeholder groups and local agencies agreed to collaborate in an integrated program of restoration and management of the [California] Bay-Delta" (Kallis et al., 2009, p. 632). It was financed through state agencies and stakeholder support, which collectively provided $3 billion capital for the program during its 22 years, from 1994 to 2006 (Kallis et al., 2009, p. 634). Indeed, CALFED "has been cited as an exemplar of good governance: policymakers, stakeholders and scientists collaborated in ad hoc, self-organizing work-groups under a fluid institutional structure and produced innovative agreements that surpassed long-standing stalemates" (Kallis et al., 2009, p. 635). The program allowed for adaptive governance and thereby ensured that new developments and innovations could be integrated within the soft-law solutions on which it relied. It also offered the participating companies and organizations opportunities to develop socially and environmentally sound innovations by collaborating with each other. An example of a process innovation that resulted from CALFED is the Environmental Water Account (EWA), where agencies trade water for different uses in real time—for example, agencies may trade water for drinking with water for fisheries and agriculture (Kallis et al. 2009).

While certain critics assert that CALFED has failed to achieve its overarching results, the program has nonetheless been successful in generating capacity-building, institutional learning, small scale innovations and soft-law agreements for water use and distribution within a deliberative framework that was able to accommodate the interests of all participating stakeholders (CALFED, 2014; Kallis et al. 2009).

Given the global scope of the problem and the success of CALFED, similar solutions might be possible in the context of international policy and governance. Two relevant

governance initiatives that appear to have potential are the EU Water Framework Directive (WFD, 2014) and the CEO Water Mandate of UNGC (CEO Water Mandate, 2014). The EU Water Framework Directive (WFD) commits EU member states to achieve "'good status' for all waters by a set deadline" (WFD, 2014). Orchestrated by the EU, the WFD takes a deliberative approach to how individual EU member states implement the directive in the area of river basin management. The EU acknowledges that "in getting our waters clean, the role of citizens and citizens' groups will be crucial" (WFD, 2014) and offers two reasons for public deliberation before implementation. First, in order to develop innovative solutions that reflect the interests of diverse groups of stakeholders, it is necessary to include those affected. Second, deliberation creates transparency within the norm-setting process, which helps overcome problems of enforceability and is able to facilitate collaboration (Vaccaro and Echeverri, 2010; WFD, 2014).

The second related scheme that we examine here, the CEO Water Mandate, is an activity domain of the UN Global Compact that emerged as part of the UNGC's strategy of diversification (Sethi and Schepers, 2014). It aims to secure corporate water stewardship and to induce corporations to commit to sustainable water usage (CEO Water Mandate, 2014). While the CEO Water Mandate has been heavily criticized, especially for allowing only business organizations to become members, and thus excluding NGOs and other affected social groups from participation (Sethi and Schepers, 2014), the UN as such has the potential to improve the governance of water management through successful orchestration. Thanks to its connection to the UNGC, the CEO Water Mandate would be a good starting point for responsible governance that enables organizations to self-regulate innovation in water use and to distribute the resulting products and processes widely. If the CEO Water Mandate put in place a more deliberative governance structure that allows all affected groups to participate, it could provide a platform for pooling resources and exchanging knowledge on global water management, both of which could drive successful innovation in that area.

Conclusion

The constraints on Earth's life support system require global actors to make concentrated efforts towards sustainable development. These efforts concern especially business organizations and their potential to contribute to SD through responsible innovation. This article has identified and discussed three key dimensions of responsible innovation: first, innovations must avoid harming people and the planet as a whole; second, innovations need to 'do good' to improve the Earth's life-support system; third, responsible global governance is necessary for achieving the first two requirements.

The article contributes to the literature on innovation management and on sustainability by combining these three dimensions and discussing the implications of responsible innovation in a globalizing business environment. We thereby developed a framework for innovation governance that addresses responsible innovation more holistically than prior approaches. The paper not only connects research in natural sciences, SD and CSR, but also connects firm-level innovation with macro-level global governance. The main proposal of this work is that global governance schemes that are based on deliberative practices and soft-law measures can complement hard-law regulations to foster responsible innovation. Furthermore, such schemes can facilitate collective innovation that is conducive to SDGs. This proposal rests on the argument that global actors need to take a holistic approach to responsible innovation, which in turn requires changing the role responsibilities of the actors involved: businesses and NGOs need to assume political responsibility by participating in the global governance of SD, and governments and intergovernmental organizations need to facilitate deliberative global governance through the responsible orchestration of these efforts.

Future research could investigate in more depth the challenges of collaborative innovation and identify contingency factors that influence its success in the context of global

governance. Researchers could try to explore and understand better the mechanisms of collaboration and negotiation that hinder or facilitate innovative solutions and thus provide valuable insights into this issue for scholars and policy makers (Schüssler et al., 2014). Furthermore, focusing on responsible innovation in relation to specific SDGs opens up many areas to future research. This article highlighted global freshwater use as an example of pressing SD challenges and outlined potential solutions that can promote responsible innovation through effective governance. Many other pressing SD challenges remain to be explored.

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Figure 1: Governing responsible innovation for sustainable development (I)

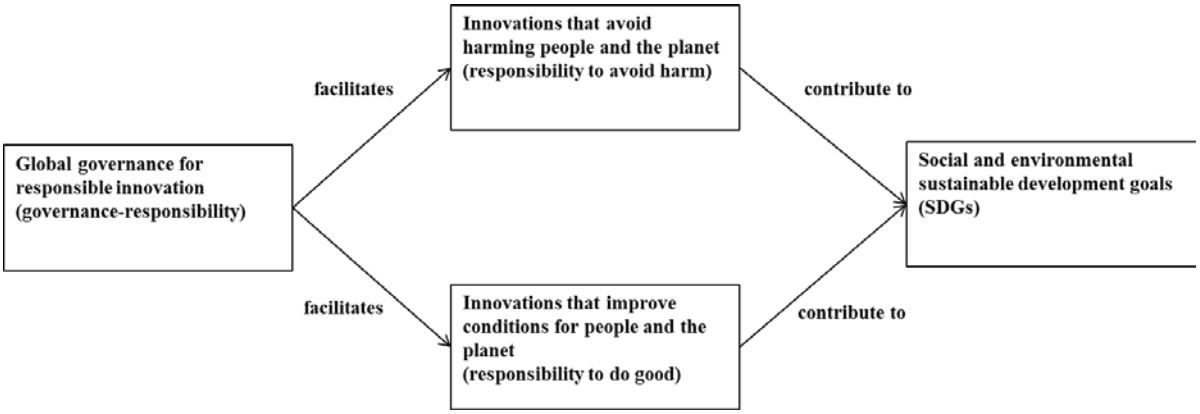
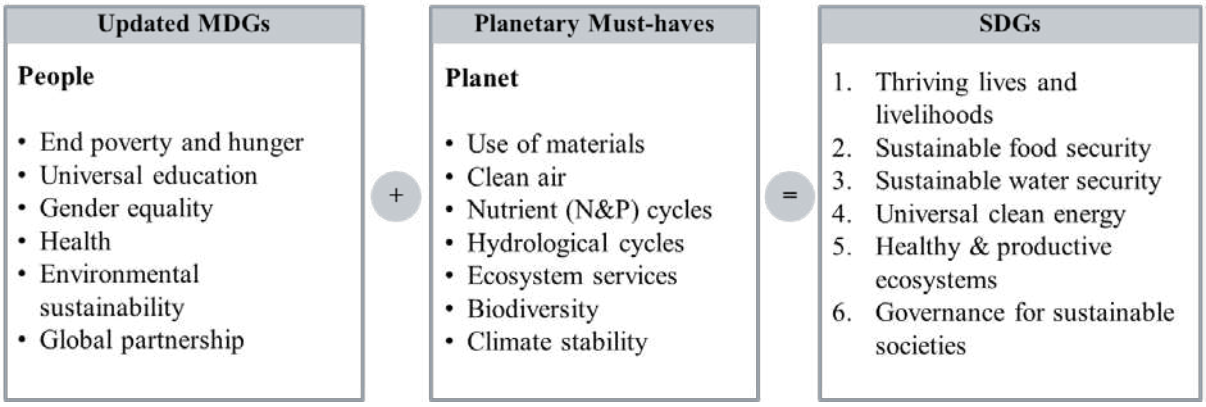


Figure 2: Sustainable development goals



Source: Adapted from Griggs et al., 2013, p. 306

Figure 3: Governing responsible innovation for sustainable development (II)

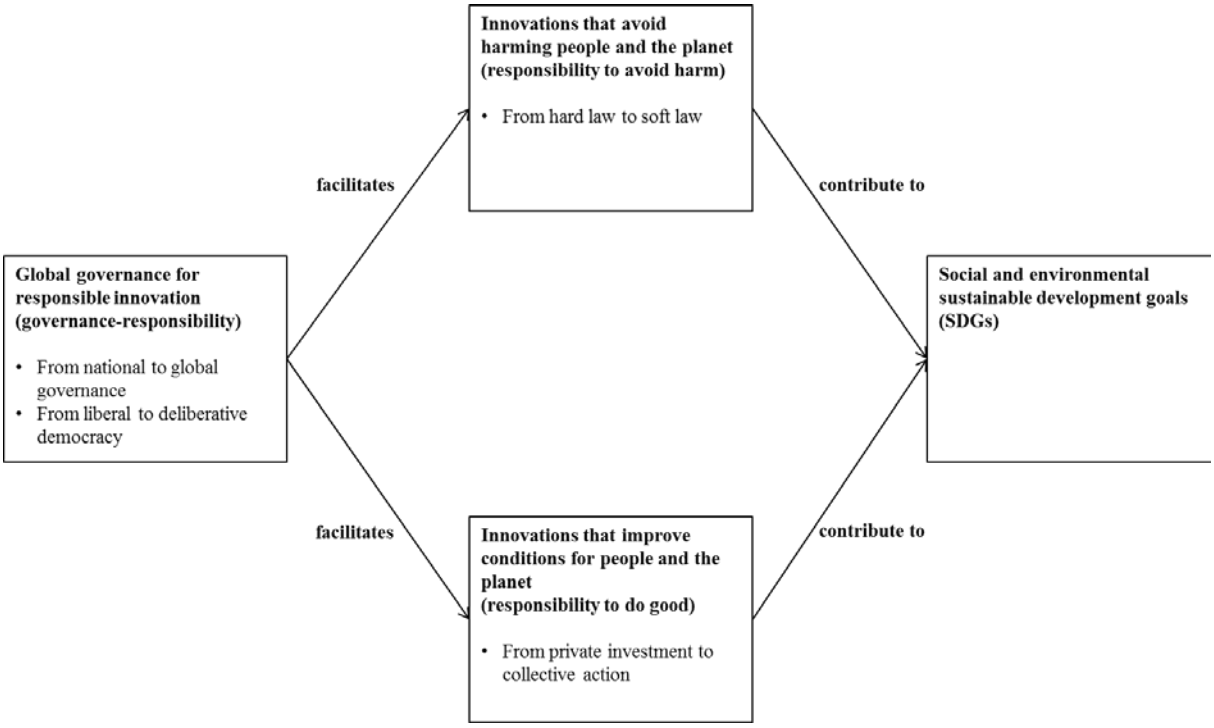


Table 1: Sustainability challenges and thresholds

Planetary Boundaries	**Current status (Threshold)**	**Copenhagen Consensus** **(Ranking of SD challenges according to suggested priorities after economic cost–benefit analysis of each challenge)**	**Millennium Development Goals (MDGs)**
Climate change (atmospheric carbon dioxide concentration in parts per million by volume)	387 (350)	1. Communicable Diseases	Goal 1: Eradicate extreme poverty and hunger
Rate of biodiversity loss (extinction rate in number of species per million species per year)	>100 (10)	2. Malnutrition and hunger	Goal 2: Achieve universal primary education
Nitrogen cycle (amount of N_2 removed from the atmosphere for human use in millions of tonnes per year)	121 (35)	3. Global trade reform	Goal 3: Promote gender equality and empower women
Phosphorus cycle (quantity of P flowing into the oceans in millions of tonnes per year)	8.5–9.5 (11)	4. Sanitation and access to clean water	Goal 4: Reduce child mortality
Stratospheric ozone depletion (concentration of ozone; Dobson unit)	283 (276)	5. Governance and corruption	Goal 5: Improve maternal health
Ocean acidification (global mean saturation state of aragonite in surface sea water)	2.90 (2.75)	6. Migration	Goal 6: Combat HIV/AIDS, malaria and other diseases
Global freshwater use (consumption of freshwater by humans in km^3 per year)	2600 (4000)	7. Climate change	Goal 7: Ensure environmental sustainability
Change in land use (percentage of global land cover converted to cropland)	11.7 (15)	8. Access to education	Goal 8: Develop a global partnership for development
Atmospheric aerosol loading (overall particulate concentration in the atmosphere, on a regional basis)	To be determined	9. Conflicts	
Chemical pollution (e.g. amount emitted to, or concentration of persistent organic pollutants, plastics, endocrine disrupters, heavy metals and nuclear waste in, the global environment, or the effects on ecosystem and functioning of Earth system thereof	To be determined	10. Financial instability	
Source: Rockstrom et al., 2009, p. 473		Source: Lomborg, 2004	Source: UN, 2012